much of the loose soil of a coral islet can be moved by a single tidal encroachment. It happened that I was riding past the very thin strip of land between Minni Minny and Barton Point the day after an abnormally high tide. The strip of land here is not more than 30 yards across, and the sea had washed right over it on the previous day, clearing away an amount of soil which was almost incredible. My companion, M. Casimir Leconte, told me that the sea had not been known to wash over this place before. It was apparent that, after a few more of such high tides as I had witnessed, a permanent breach would be made at this spot, and another lagoon outlet would be formed, which would be continually deepened as the tide set through it. At the south-eastern side of the island I noticed that the land was being rapidly destroyed on the outer shores just opposite to a half-formed barachois, whose margins are situated not 60 yards from the outer shore. If the same process of external destruction continues, whilst the barachois is deepened and scooped out from within, it will not be many years before the ocean makes a new channel into the lagoon at this point. Thus the continuous strip of land which now nearly encircles the lagoon of Diego Garcia is tending to be split up again into a series of islets. At the points where the breaches are made the tides and ocean currents will rush with great force into the lagoon, and will scour out deep channels similar to that now existing between Middle and East Islets.

These facts taken together show how the normal action of tides, winds, and waves is constantly tending to lower to the sea-level any dry land that may have been formed by elevation or otherwise. It does not seem to me to be surprising that the majority of atolls and barrier reefs are, under such circumstances, only just able to maintain their surfaces above the sea-level.

No explanation of atoll formation would be complete if it did not include an explanation of the Maldive atolls. This has been felt by Darwin, who has explained the formation according to his theory. Without attempting to enter into a lengthy discussion, I will give my own explanation of the atoll. Tilla-dou-Matte atoll is, as is well known, a huge atoll composed of atolls. The islets forming the rim of the main atoll are themselves atolls with their own lagoons; the main lagoon contains a few secondary atolls corresponding to the coral patches in an ordinary atoll. It will be generally admitted that coral reefs are constantly increasing to seaward because of the excessive growth of coral on their external slopes.[1] As the inward shores of an atoll are constantly being removed, and an atoll if completely formed tends to be broken up again into small islets when it has reached a certain size, and as the channels between the islets must be continually deepened by the scour of the tides until deep passages are formed, an atoll like Diego Garcia may be expected to reach in time a condition like that of Peros Banhos. It is probable that a large bank like the Great Chagos Bank, when it reaches the surface, can never give rise to a continuous strip of land, but must consist of a chain of islets separated by channels of some depth and by tracts of submerged reefs. The islets and tracts of reef in either case would be bounded by deeper channels, and these channels, swept by strong currents, would become wider and deeper, for corals could not thrive in them. After a time the islets would become so far isolated, and the entries into the lagoon would become so large and numerous, that oceanic conditions would prevail in the lagoon, and then there would be around each separate islet or piece of reef all the necessary conditions for the formation of a new atoll. The currents would impinge upon one side of the islet or reef, sweep round it, and give a backwash at the further side; the corals would flourish in the circumferential parts of the reef surrounding the islet, and new atolls with shallow lagoons would be formed.

In Tilla-dou-Matte the lagoons of the secondary atolls are tolerably deep. In this case they must have been formed before any land reached the surface. Applying the same reasoning as in the former case, it can readily be understood how in the case of the Great Chagos Bank, which has wide and deep breaches in many places, the isolated reefs as they grow to the surface must tend to assume an atoll form. An examination of the chart shows that this is the case. The Great Chagos Bank in the course of time will rise to the surface as an atoll composed of secondary atolls or atollons, similar to, but on a smaller scale than, the Tilla-dou-Matte atoll. The explanation of atollons in the centre of a large lagoon in which oceanic conditions have been established, is quite obvious.

THE ROYAL HORTICULTURAL SOCIETY.

On Tuesday, March 27, the Scientific Committee of the Royal Horticultural Society met in the Committee-room of the Drill Hall. Among the numerous subjects brought forward were the following:—

Dispersal of the Seed in Pinus insignis.—Dr. Masters, alluding to the great differences that exist in the species of *Pinus*, as to the time at which the constituent scales of the cone separate in order to liberate the seed, showed a series of cones of *Pinus insignis*, the oldest of which bore the date 1864. In this all the scales were widely separate. The most recent cones dated from 1877, and in them the scales were not at all separated. Between these two extremes, cones were shown exhibiting almost every intermediate stage of separation. It is to be remarked that the separation begins generally just above the centre of the pendulous cone on the side furthest away from the branch, at the place where the excentricity of the cone, due to the free exposure to light and air, and the absence of obstacles afforded by the branch was greatest, and that it follows a spiral course towards the base of the cone. The scales separate in successive spiral coils, till, at length, all except a few at the base and apex respectively, and which are probably sterile, are separated one from the other.

Semi-double and other Orchids.—Dr. Masters explained the construction of numerous malformed orchids which were interesting as throwing light on the morphology of the order. Some extraordinary malformations of Fuchsias were shown, and a drawing was exhibited of a magnificent new Anthurium, which had appeared accidentally with an importation of *Cattleya Gaskelliana*, in the garden of the Right Hon. J. Chamberlain. The heart-shaped leaves are of gigantic size, and the large boat-shaped spathe is of the richest crimson colour.

Eucalyptus urnigera.—Dr. Masters showed specimens of this Tasmanian species in flower and fruit. They had been received from Whittinghame Gardens, Prestonkirk, near Edinburgh, not far from the sea, and where the tree is perfectly hardy.

Daffodil with Crested Corona.—Rev. E. C. Gabbett sent through Dr. Masters two flowers of a curious Daffodil from plants growing on his lawn in Co. Limerick. The "frill," or outgrowth, is produced from the outer surface of the corona, which has thus a very peculiar appearance.

Douglasia lævigata.—Mr. G. F. Wilson alluded to this plant as having been shown for the first time. It is a low-growing Primulaceous plant, with tufted leaves and lilac flowers, like those of an Androsace, but larger, and with the tube of the corolla longer than the calyx, and with only two seeds to the capsule. The species are the natives of North-Western America, the first known species having been collected by Douglas not far from the sources of the Columbia River, and named in his honour by Dr. Lindley.

Araucaria imbricata Timber.—Mr. Ford, gr., Leonardslee, exhibited slabs of wood cut from a tree of this species, and which at 6 feet from the ground girthed 26 inches, the tree being 35 feet in height. The wood was yellow, soft, evenly grained, and, judging by the distance between the rings, quickly grown.

Numerous other plants and objects of interest were exhibited and commented on.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 15.—"A Class of Functional Invariants." By Mr. A. R. Forsyth, F.R.S.

The memoir is occupied with the investigation of a class of functional invariants, constituted by combinations of the partial differential coefficients of a dependent variable, z, with regard to two independent variables, x and y. The definition of the invariant is given by the property that, when the independent variables are transformed to X and Y, and the same combination as before is formed with regard to these new variables, the equation

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[1] This statement may at first sight seem at variance with what I have just said about the rapid destruction of land on the outer and inner shores of an atoll; but in the latter case it is *land above water* that is destroyed. Coincidently with this process the reef rock below water is constantly tending to raise itself and to spread in all directions, owing to the perpetual growth of corals and the accumulation of their skeletons.

$$\Phi = \left\{ \frac{\delta(x, y)}{\delta(X, Y)} \right\}^m \phi$$

is satisfied.

The transformations for which any detailed results are given are of the general homographic type. The characteristic properties of such invariants are :—

(i.) Every invariant is explicitly free from the variables, but necessarily contains both the differential coefficients p and q of the first order.

(ii.) It is homogeneous in the differential coefficients, and is of uniform and the same grade in differentiations with regard to each of the independent variables.

(iii.) It is symmetric or skew symmetric with regard to these differentiations.

(iv.) It satisfies four differential form-equations and two index-equations, all linear and partial of the first order.

An invariant is said to be proper to the rank n, when the highest differential coefficient of z which occurs in it is of order n. By means of the solutions of the form-equations, the following propositions relating to irreducible invariants in a single dependent variable, z, are established :—

Invariants can be ranged in sets, each set being proper to a particular rank.

There is no invariant proper to the rank 1; there is one proper to the rank 2; there are three invariants proper to the rank 3.

For every value of n greater than 3 there are $n + 1$ invariants proper to the rank n, which can be chosen so as to be linear in the partial differential coefficients of order n.

Every invariant can be expressed in terms of this aggregate of irreducible invariants; and the expression involves invariants proper to rank no higher than the order of the highest differential coefficient which occurs in that invariant.

Some of the properties of the irreducible invariants involving differential coefficients of two dependent variables are obtained, and, in particular, it is shown that there is a single irreducible simultaneous invariant proper to the rank 1, and that there are four such invariants proper to the rank 2.

The theory of eduction is next considered, with some examples. Finally, it is shown that the theory of binary forms can be partly connected with functional invariants.

March 22.—"Second Preliminary Note on the Development of *Apteryx*." By T. Jeffery Parker, B.Sc., C.M.Z.S., Professor of Biology in the University of Otago. Communicated by W. K. Parker, F.R.S.

Chemical Society, March 15.—Mr. W. Crookes, F.R.S., in the chair.—The following papers were read :—The nature of solutions as elucidated by the heat evolved on their dilution; Part 1, calcium chloride, by Mr. S. U. Pickering. To determine the nature of the action which takes place on diluting aqueous solutions, the author has examined calcium chloride, and, in a series of elaborate experiments, has obtained results which form a curve of great regularity. This regularity, however, is only apparent, since on differentiation a number of independent curves are obtained, each of which on further differentiation gives a straight line. The points at which these lines meet, when produced, indicate percentages of water corresponding to distinct hydrates of the salt, and moreover coincide in every case, within the limits of experimental error, with the points obtained by treating in a similar manner the curve expressing the densities of the various solutions. The author contends that these results, taken in conjunction with the fact that the variation in the electrical conductivity and the density of sulphuric acid on diluting with water also point to the existence of certain hydrates in solution, make it no longer reasonable to doubt that solutions do in reality consist of such hydrates, and is of opinion that any theory of the nature of solutions which ignores their existence must be rejected absolutely and for ever. A new form of mixing calorimeter, devised for these experiments, was exhibited.—The action of thiocyanates on aldehyde-ammonias, by Dr. A. E. Dixon.—Carboxy-derivatives of quinone, by Dr. J. U. Nef. Ethylic paradiketohexamethylenecarboxylate, obtained by the reduction of ethylic quinonetetracarboxylate with zinc dust, exists apparently in three distinct modifications, only two of which, however, have been studied—the one modification is green and crystallizes in needles, the other is yellow and crystallizes in plates; after fusion, the former appears dark yellow and the latter bright yellow. If either modification be separately dissolved in carbon bisulphide, a solution is obtained from which the two substances crystallize out together; the solution also has the same colour and the same absorption spectrum whichever modification be dissolved. The author calls attention in the paper to a number of similar cases of dimorphism.—The action of acetone on ammonium salts of fatty acids in the presence of dehydrating agents, by Dr. S. Ruhemann and Mr. D. J. Carnegie.—A method of estimating nitrites either alone or in presence of nitrates and chlorides, by Mr. T. C. Day.

PARIS.

Academy of Sciences, March 26.—M. Janssen in the chair.—New theory of the equatorial *coudé* and of equatorials in general (continued), by MM. Lœwy and P. Puiseux. Here are given the general formulas promised in the previous communication, together with the terms depending on the position of the outer glass.—On the relations of atmospheric nitrogen with vegetable humus, by M. Th. Schlœsing. A detailed account is given of the experiments carried out according to the already described method for the purpose of ascertaining whether gaseous nitrogen is fixed by vegetable soil. The disappearance of the oxygen shows in six different cases that the combustion of the organic substances takes place in various degrees depending on the quantity and nature of such substances. During this combustion nitric acid is formed with disappearance of the ammonia. The volume of gaseous nitrogen contained in the soil does not perceptibly vary.—On the absorption of saline substances by plants (continued), by MM. Berthelot and G. André. The experiments here described deal with the acetate of potassa, an organic salt analogous to those present or produced in the plants; also with the nitrate of potassa, the formation or accumulation of which is characteristic of certain species, especially of the Amaranthus group. This accumulation is shown to depend rather on the period of vegetation than on the proportion of the salt in the ground.—New nebulæ of a remarkable character discovered in the Pleiades, by means of photography, by MM. Henry, and described by M. Mouchez. Besides a new nebula round Maia in the Pleiades, the more recent researches of MM. Henry have revealed a great mass of cosmic matter covering a large part of this constellation. But the most remarkable discovery, and one of an absolutely unique character, is a rectilinear thread of nebular matter projected from the central mass nearly in the direction from east to west for a distance of 35′ to 40′ of arc, but with a thickness of no more than 3″ to 4″. This thread crosses on its path seven stars, which it seems to string together like the beads on a rosary, and slightly changes its direction at the point where it meets the largest of these stars. A second streak, somewhat similar, but shorter, is perceptible in the middle of the nebular mass.—Preliminary work for the execution of the photographic chart of the firmament, by M. Mouchez. Reference is made to the publication of a *Bulletin* specially devoted to this object. Two more Observatories, those of Potsdam and Oxford, are announced as intending to take part in this great work, making thirteen stations altogether. These, it is stated, are already sufficient to secure the completion of the undertaking in the course of four or five years.—Treatment of auriferous sands by amalgamation, in ancient times, by M. Berthelot. The second part, just published, of the already noticed "Collection des Alchimistes grecs," contains the works of Zosimus, a writer of the third century of the new era, dealing with the extraction of gold by means of its natural ores treated with mercury. This process appears to have been substituted for a still more ancient method, in which the ore was fused with lead, salt, a little tin, and barley bran, and submitted to a genuine process of refining.—Observations of the Comet 1888*a*, made at the Paris Observatory with the equatorial of the West Tower, by M. G. Bigourdan. The observation here recorded was taken on March 25, when the comet, discovered at the Cape, on February 18, by M. Sawerthal, was approaching the northern hemisphere.—On a new mercury-bath for the observation of the nadir, by M. Périgaud. This valuable appliance at last gives the long-sought solution of the problem, how to employ the mercury-bath for determining the vertical, and for taking observations by reflection in all states of the weather, and on ground subject to the constant vibrations produced by carriage traffic, as in large towns.

BERLIN.

Meteorological Society, March 6.—Dr. Vettin, President, in the chair.—Dr. Zenker gave an account of his work, which has been awarded a prize by the Paris Academy, on the distribution of heat over the surface of the earth. When considering the total heat which reaches the earth's surface, it is of course dependent upon the distance of the sun, and is greater at perihelion than at aphelion in the ratio of the inverse square of the sun's distance. The varying ellipticity in outline of the earth in its various positions has no influence on the heat received owing to the extremely slight difference thus produced. If any one point of the earth's surface is alone considered, then the heat received is determined by the sine of the sun's altitude or the cosine of its zenith distance, for which the speaker gave an equation expressed in terms of amplitude and declination. From the above relationships it follows, leaving the air out of account, as has usually been the case, that the heat received by the Pole on a summer day is greater than that which falls on a point at the equator. Thus taking as unit the heat received during twenty-four hours by a place at which the sun is in the zenith, the North Pole receives an amount of heat represented by 0·397, and a point on the equator an amount represented by 0·292. But the air absorbs a large part of the sun's heat. The speaker considered it unreliable to estimate the height of the atmosphere from the amount of heat-absorption, as is frequently done, inasmuch as the chief absorption takes place in the deeper layers of the air. For the determination of the coefficient of absorption Dr. Zenker accepts the values obtained by Langley from his bolometric experiments, with a reservation, however, as regards the absorption which takes place in its highest layers, which he did not admit. One factor of great importance is the diffusion of heat, already described by Clausius, from the small particles of water, dust, and air in the atmosphere, which are calculated under other definite assumptions. Another factor which must not be lost sight of is the reflection of heat at the earth's surface; this is calculated for the three cases of a surface of water, land, and snow. Special tables are given of the heat reflected from these three kinds of earth-surface for separate places per day and per year. The application of this theoretical part of the research to the climatology of the earth's surface, the speaker intends to lay before the Society at some future time.—Dr. Less drew attention to the meteorological conditions of the past few days. A minimum-temperature on March 1 was succeeded by a thaw on the evening of the 2nd, which was followed by a second very low temperature which again gave way to a thaw on the 6th. The rise and fall of the barometer corresponded to the above: the very considerable double variation in atmospheric pressure was caused by a minimum passing through South-West Sweden across the East Sea to Russia, which was succeeded by a partial minimum following the same course. Exactly similar meteorological conditions were in existence from February 4, and were caused by a minimum with its succeeding partial minimum following the same course as above. Such an exact similarity of path and action of two minima is of very rare occurrence, and deserves to be carefully studied: on both occasions, in February and March, very wintry weather was observed.—Dr. Hellman drew attention to the unusually heavy snow-fall of the past winter. As yet the maximum number of days on which snow falls in Berlin has been fifty, but this year up to the present time it has already fallen on fifty-eight days; in the same way, until this year never more than eight consecutive days of snow-fall have been observed, but this winter there has been one period of sixteen consecutive days on which snow has fallen.

STOCKHOLM.

Royal Academy of Sciences, March 14.—Studies on the Characeæ and Violæ of the Isles of Gotland and Oeland, by Dr. Wahlstedt.—Studies on the geographical distribution of the plants in the province of Wermland, by Dr. Ringius.—On the currents of disjunction, by Dr. Mebius.—On the institution of pendulum observations in Sweden, by Prof. Rosén.—A review of the Orthoptera of Scandinavia, with descriptions, by Dr. Haij.—Analyses of gadolinite and hornilite, by Dr. W. Pettersson.—On the production of nitro-cymol and its products of oxidation, by Prof. Widman and Dr. Söderbaum.—On the occurrences of *Limnadia lenticularis* on the Isle of Nordkoster in the province of Bohus, by Hr. Hanson.—A thunderstorm combined with water-spouts near Upsala, by Hr. Th. Wigertz.—On fossil wood from Egypt and Eastern Asia, by Prof. Schenk, of Leipzig.—Volcanoes in the interior of the north-eastern parts of Iceland, by Hr. Thoroddsen, of Reykjavik.—On the determination of the constants in the diurnal rotation, by Dr. Bohlin.

AMSTERDAM.

Royal Academy of Sciences, February 25.—M. Martin exhibited a geological chart of the course of the River Surinam, appending the communication that, during his stay in the West Indies, he succeeded in discovering the geological formation in which the gold occurring in those parts, and long since known as wash-gold, was originally deposited. This formation is the crystalline schist, a stratum in which, in Brazil also, most of the gold is met with. The speaker urged that Brazil and Surinam offer striking points of resemblance both in the order and nature of their stratifications.—M. de Vries made a communication on his determination of the molecular weight of raffinose. His results, based upon physiological methods, tended to support the formula of Loiseau and Scheibler,

$$C_{18}H_{32}O_{16} + 5H_2O.$$

—M. Hubrecht described the early stages in the development of the blastodermic vesicle of the hedgehog. He claimed that the stages observed and described by him go a long way towards explaining the questionable points in the early stages of the human blastodermic vesicles that have yet been noticed.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Fundamental Principles of Chemistry: R. Galloway (Longmans).—Reminiscences of Foreign Travel: R. Crawford (Longmans).—An Examination of the Theory of Evolution: G. Gresswell (Williams and Norgate).—Johnston's Botany Plates, II. (Johnston).—Key to the Volapük Grammar: A. Kirchhoff (Sonnenschein).—Specimens of Papers set at the Army Preliminary Examinations, 1882-87 (Macmillan).—Companion to the Weekly Problem Papers: Rev. J. J. Milne (Macmillan).—An Indictment of Darwin: O. Dawson (Freethought Publishing Company).—An Increase in the Produce of the Soil through the Rational Use of Nitrogenous Manure: P. Wagner; translated by G. G. Henderson (Whittaker).—Smoke in Relation to Fogs in London: Hon. Rollo Russell.

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